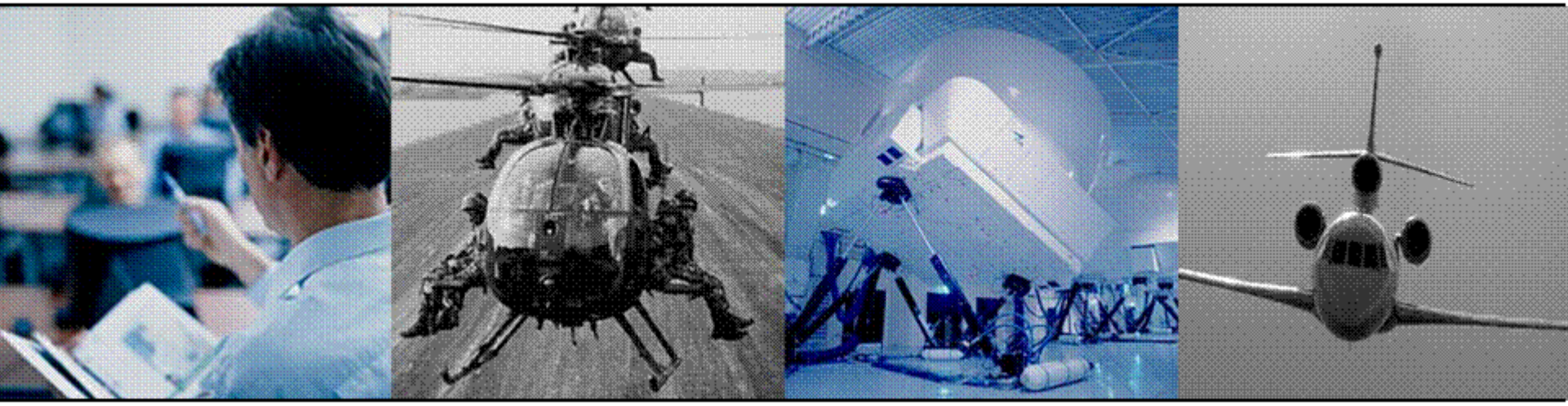

Applying Simulation to Study Human Performance Impacts of Evolutionary and Revolutionary Changes to Armoured Vehicle Design

Mark Espenant

April 2006

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- Crisis Management Centers
- Original Equipment Manufacturers

Locations:

- Canada, US, Germany, UK, Australia

Simulation Based Professional Services

Simulation Laboratories to Support Services

Simulation Labs study alternative designs, tactics, and procedures, at the Tactical, Operational, and Strategic levels.

Strategic Level

Operational Level

Tactical Level

Presentation Content

- Armoured vehicle design challenges
- Why use simulation?
- Past and current projects
- Activities related to conference themes
  - Perceptual requirements for displays
  - HCI interactions issues
  - Training approaches
  - Measurement of human performance
  - Augmented, mixed, and virtual environments
  - Future military applications
- Conclusion

Armoured Vehicle Design Challenges

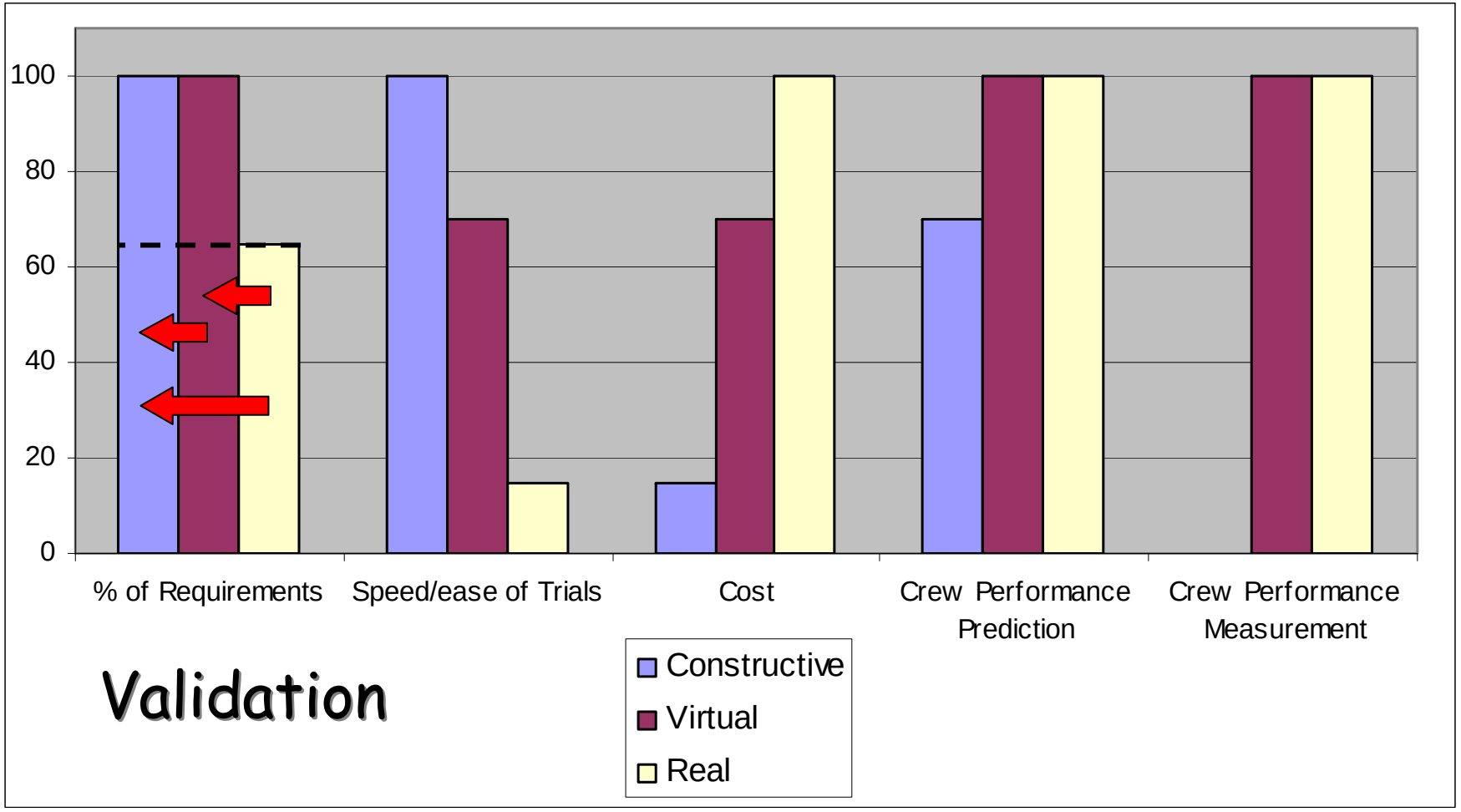
- Advanced technologies
  - Faster, lighter, more capable…but more expensive and complex
- Information & task overload
  - Net-centric info must be filtered
- Situation Awareness
  - What do crews need to know?
- Limitations on vehicle size & weight
  - Airlift, mobility characteristics
- Reduced crew size
  - Do the same tasks? Rotate crews?
- Common vehicles
  - “Special equipment vehicles”

Why Simulation?

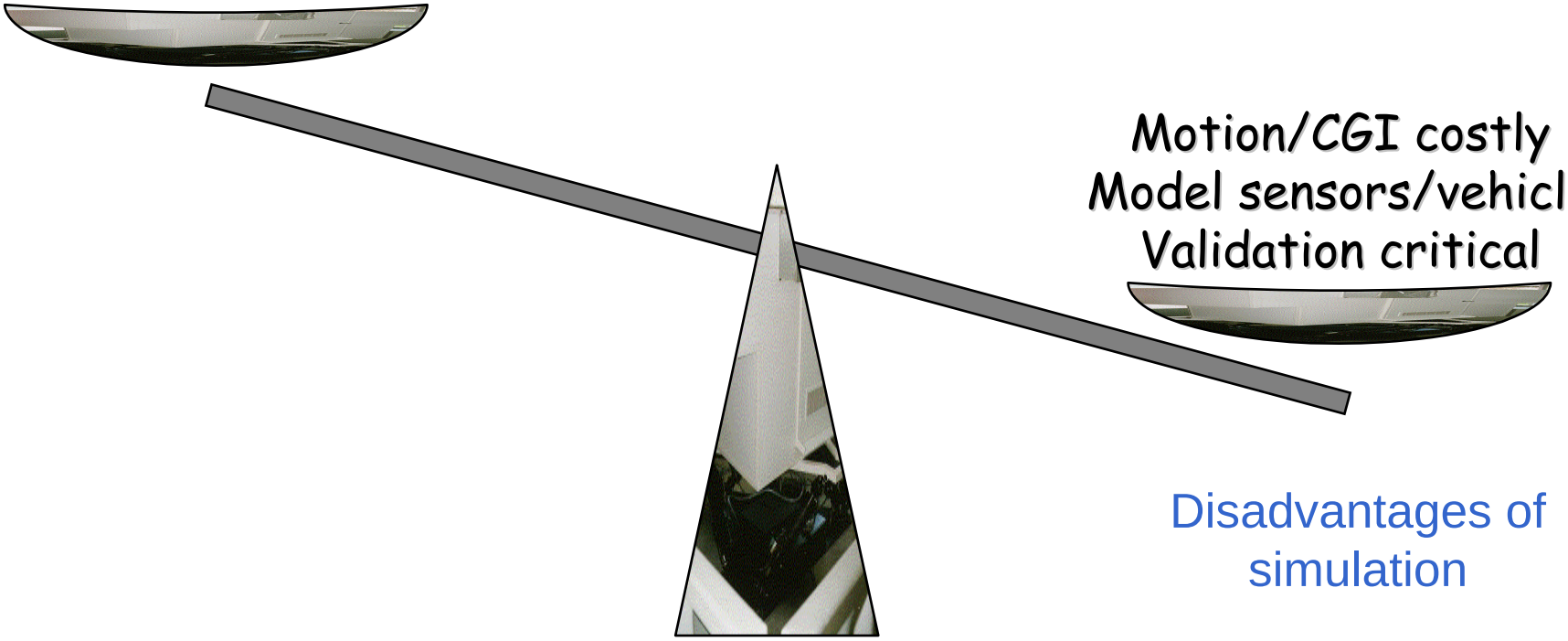
- Three kinds of simulation:
  - Live
    - Real people in real situations in real vehicles
  - Virtual
    - Real people in simulated environments
  - Constructive
    - Simulated (computer-generated) people in simulated environments

A consistent theme in our projects is the use of all three environments as best suited to the required results

Comparison of Simulation Environments



Advantages of Virtual Simulation

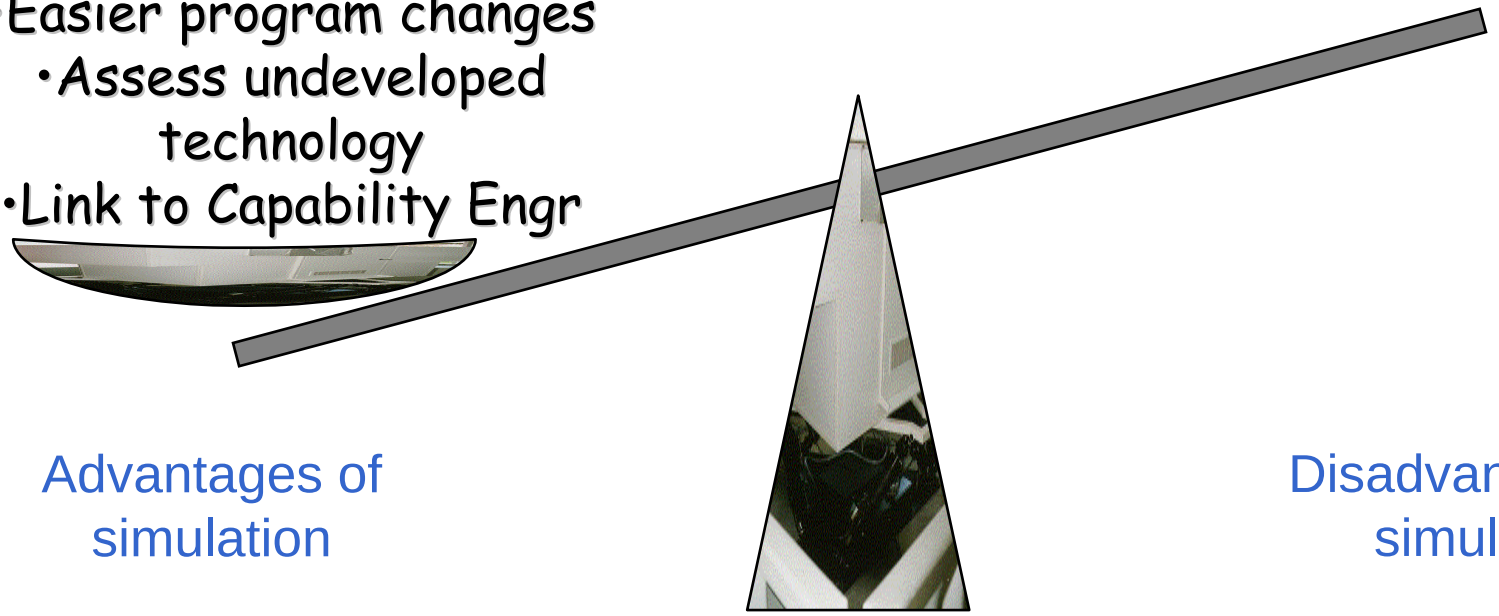


Disadvantages of simulation

Advantages of Virtual Simulation

- Easier/more varied/reproducible trials
- Use commercial components and unqualified software
- Not limited by vehicle configuration
- Rapid SMI prototyping
- Easier/cheaper development
- Easier program changes
- Assess undeveloped technology
- Link to Capability Engr

Motion/CGI costly
Model sensors/vehicle
Validation critical

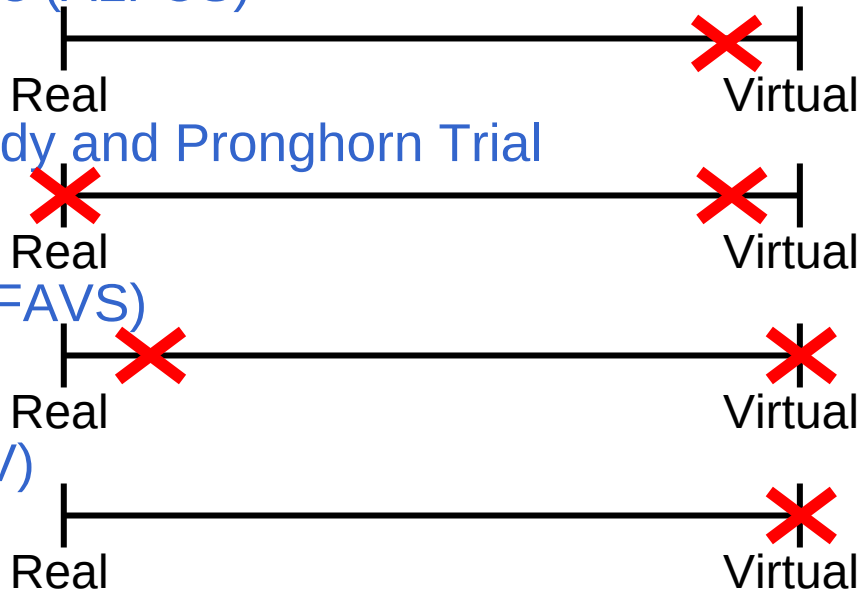


Advantages of simulation

Disadvantages of simulation

Past and Current Projects

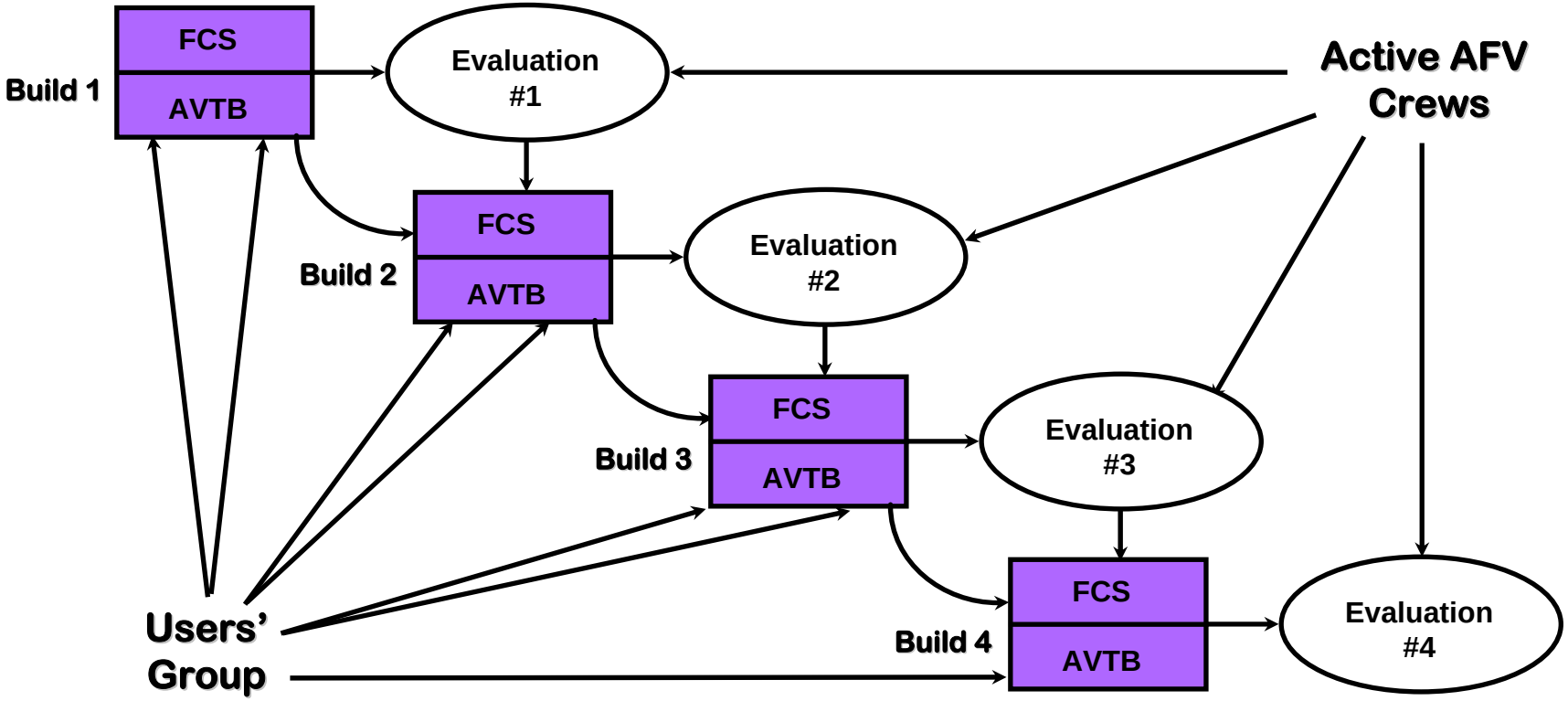
- Advanced Land Fire Control Systems (ALFCS)
- Defensive Aides Suite Definition Study and Pronghorn Trial
- Future Armoured Vehicle Systems (FAVS)
- Multi-Mission Effects Vehicle (MMEV)
- Sponsored by Defence R&D Canada, client General Dynamics Canada



Armoured Vehicle Test Bed

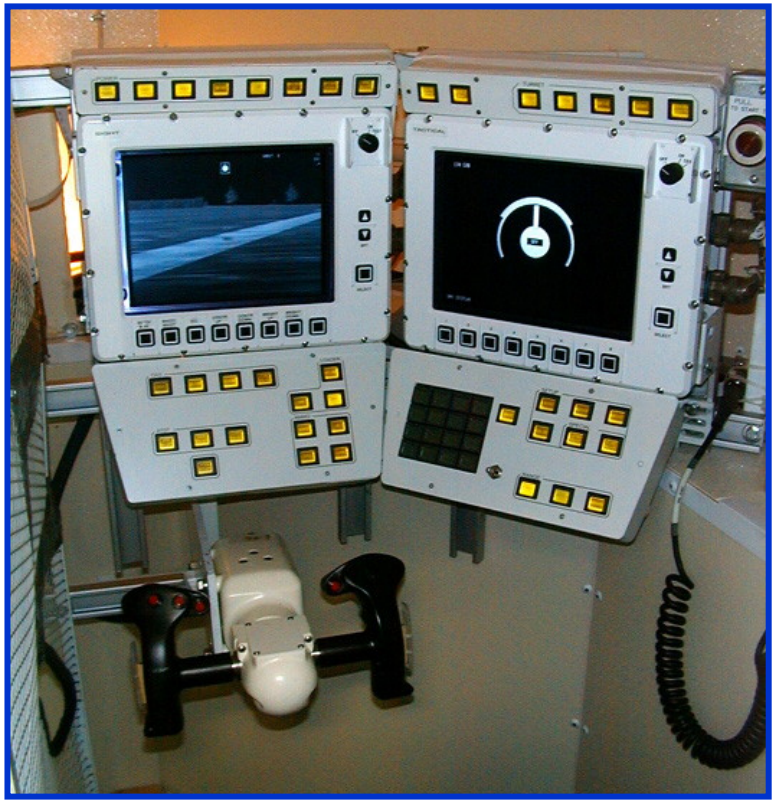
- 6 DOF motion platform
- AFV crew enclosure
- Computer-generated imagery and enemy vehicles
- Sensor and host vehicle models

Evaluation Methodology



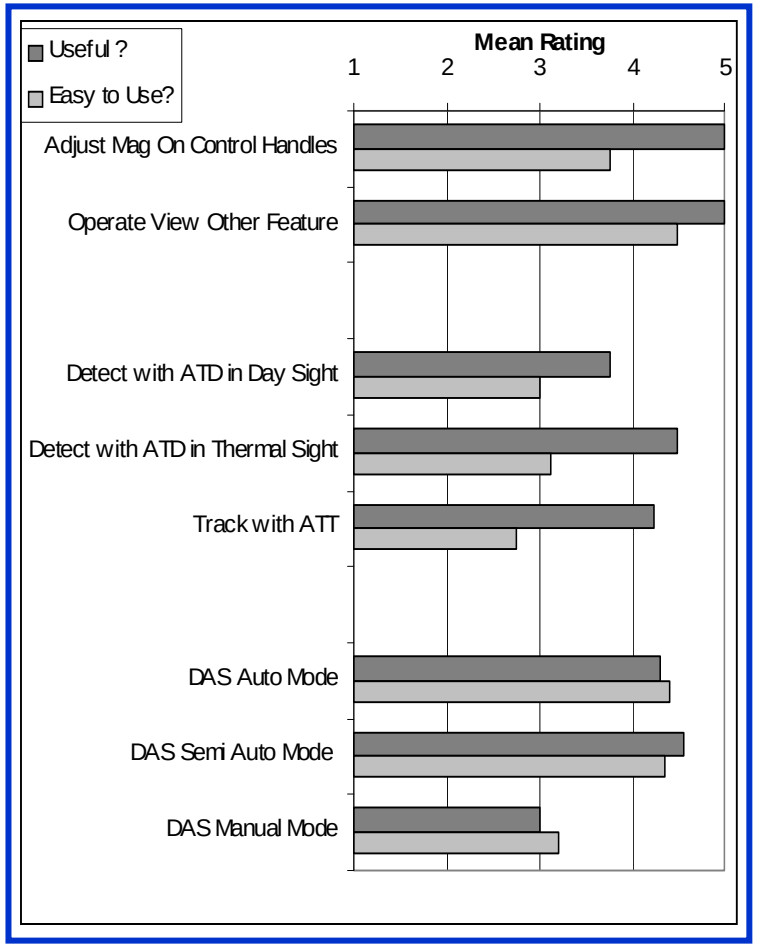
ALFCS New Features

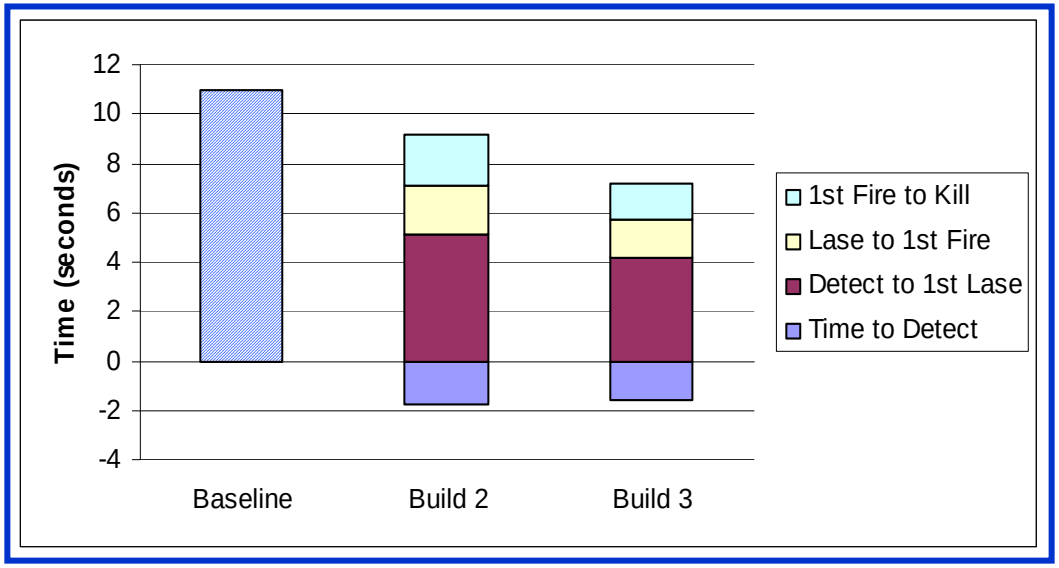
- 2-person turret with autoloader
- Relaxed-view sights/integrated control panel
- Multi-function control handles
- Basic Defensive Aides Suite
- Automatic Target Detection/Tracking
- Image enhancement
- Wide Angle Surveillance system
- Scan path/Fire points
- Integrated tactical display



ALFCS Results

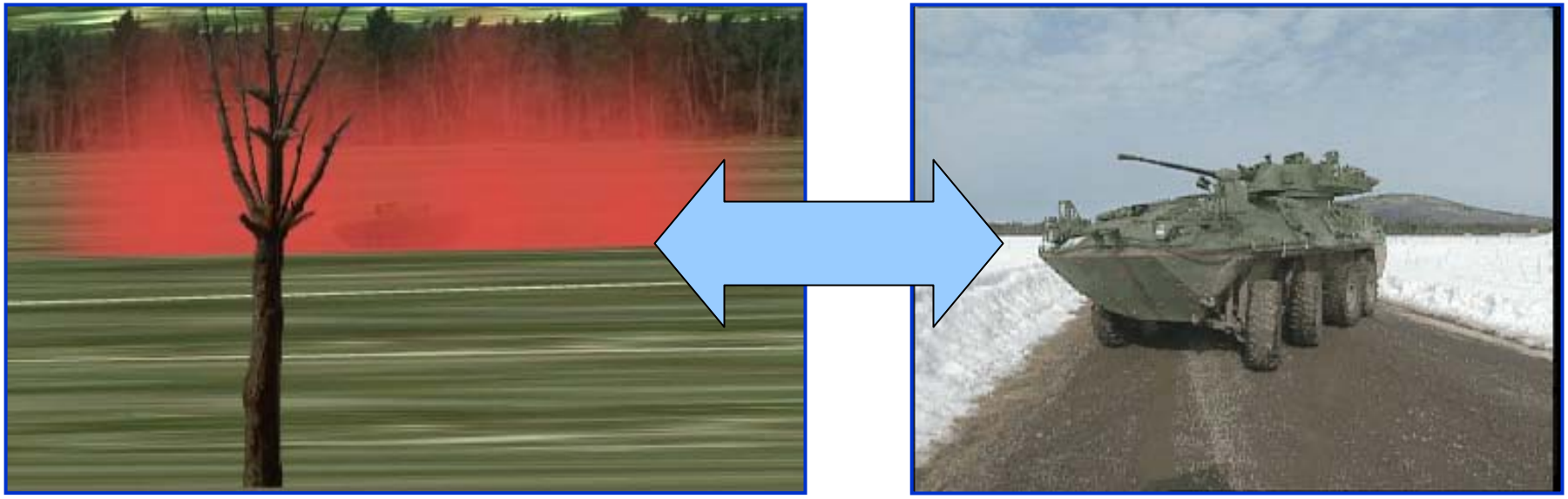
- Measurement of Human Performance and subjective crew opinion
  - Increase in engagement speed and accuracy
  - Suitability of relaxed view displays
  - Improvement in survivability
  - Design of OMI and symbology
- Actual FCS used in Mobile Gun System



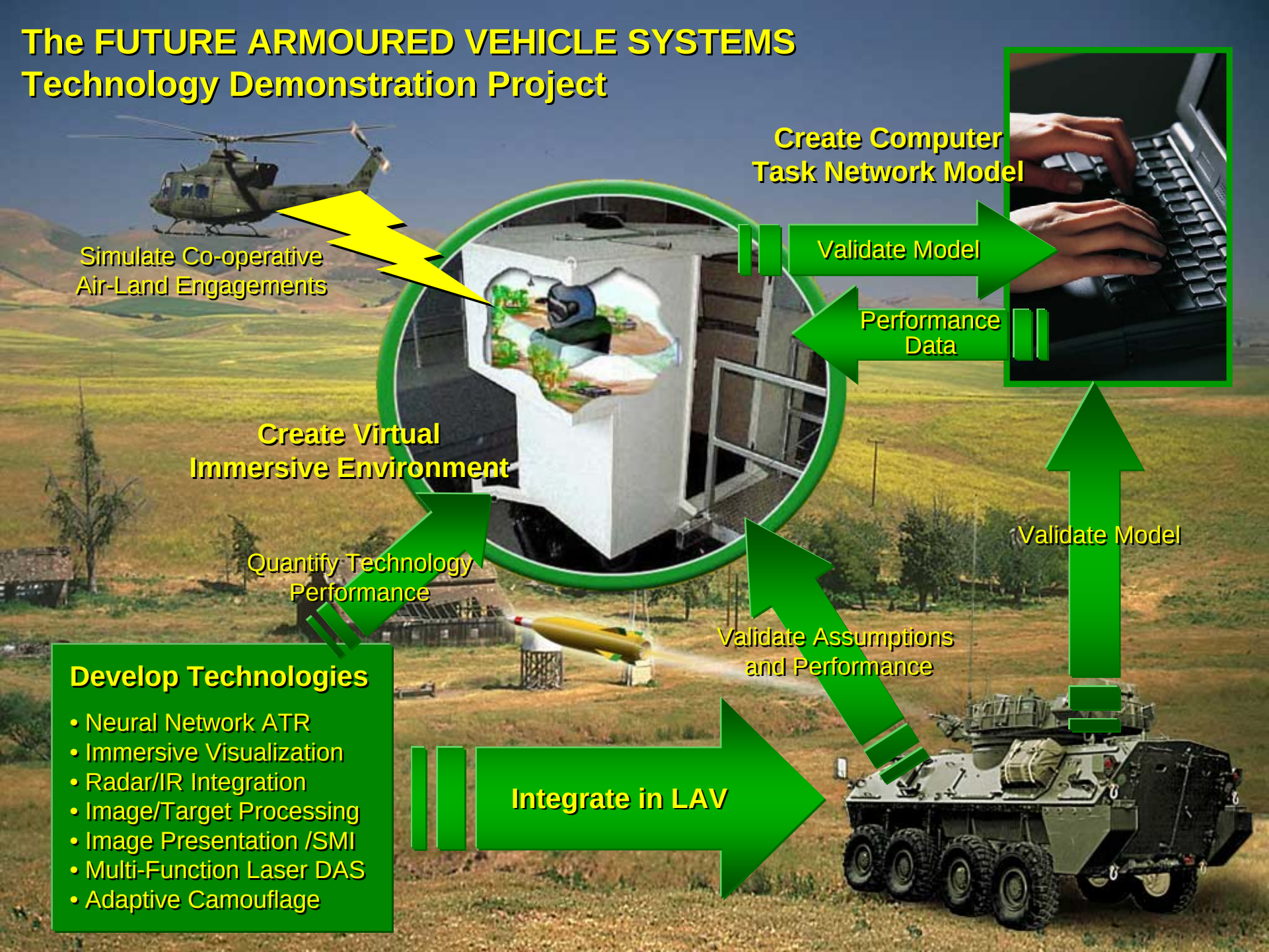


DAS Live/Virtual Comparison

- DAS implementation in ALFCS virtual environment by General Dynamics Canada
- Real DAS implemented in LAV by Litton Systems
- CAE Professional Services conducted HF design of virtual DAS, and evaluation in field and lab of both systems
- Very similar evaluation results – V&V is important!



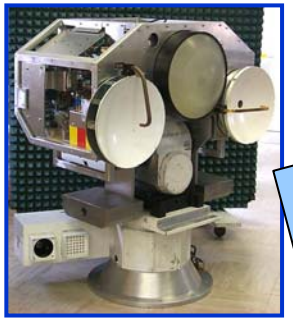
The FUTURE ARMOURED VEHICLE SYSTEMS Technology Demonstration Project



IVS

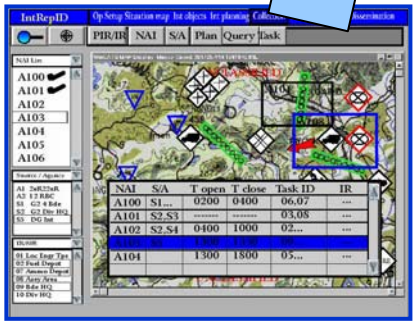
IR

DAS



Radar

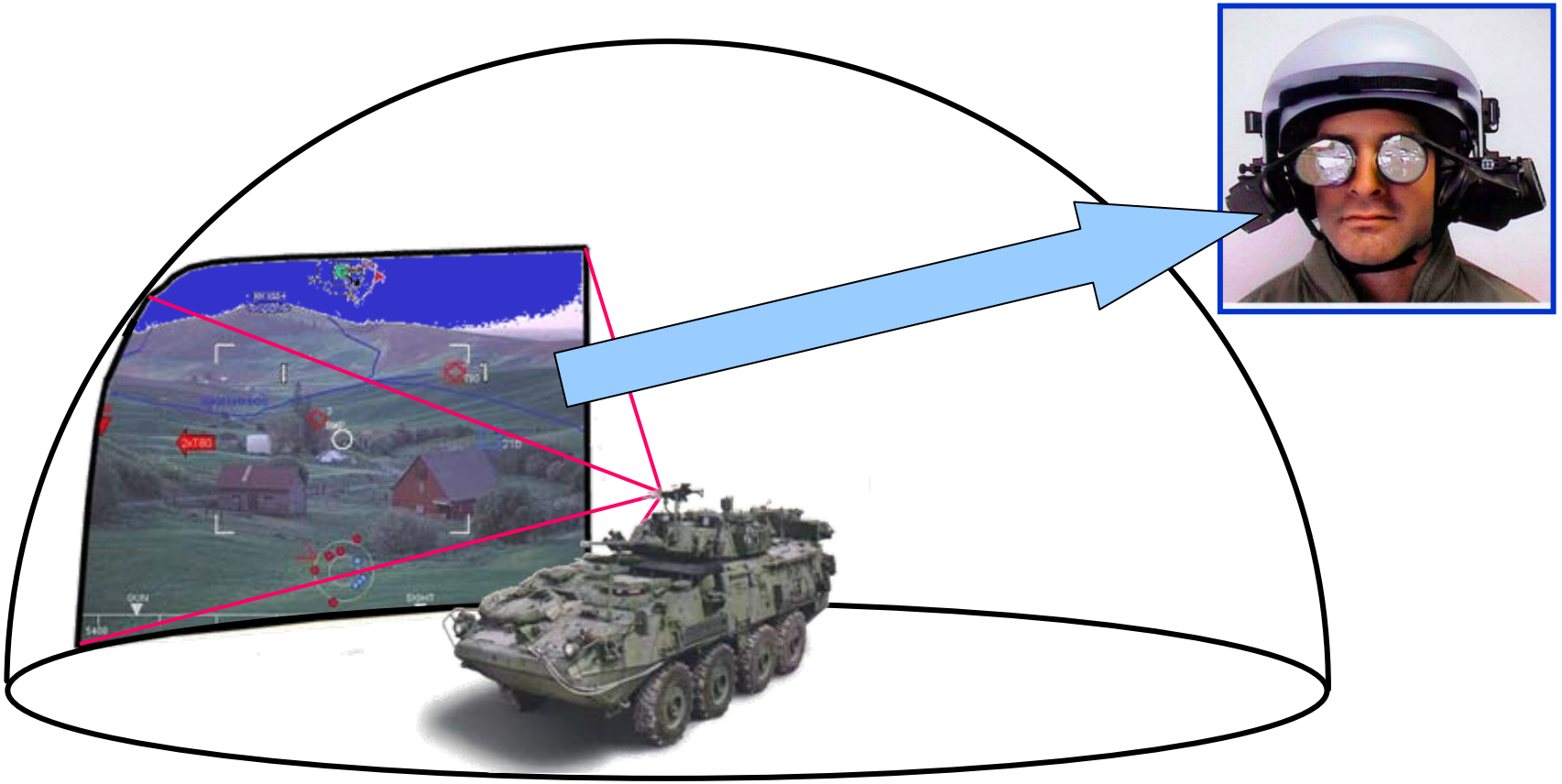
Target Acquisition Fusion Computer



BMS Data

Biomimetic ATR

FAVS Head-Mounted Display



FAVS Operator-Machine Interface (incl HCI)

Joysticks

Two joysticks mounted on seat armrests
- **Movement controls centre of view, fine aim, and 'flies' vehicle in digital terrain**
- **Buttons for all OMI functionality**

Seat

-**Full reclined backrest with armrests**
- **5-point harness**
- **Push-to-talk for radios on armrests**

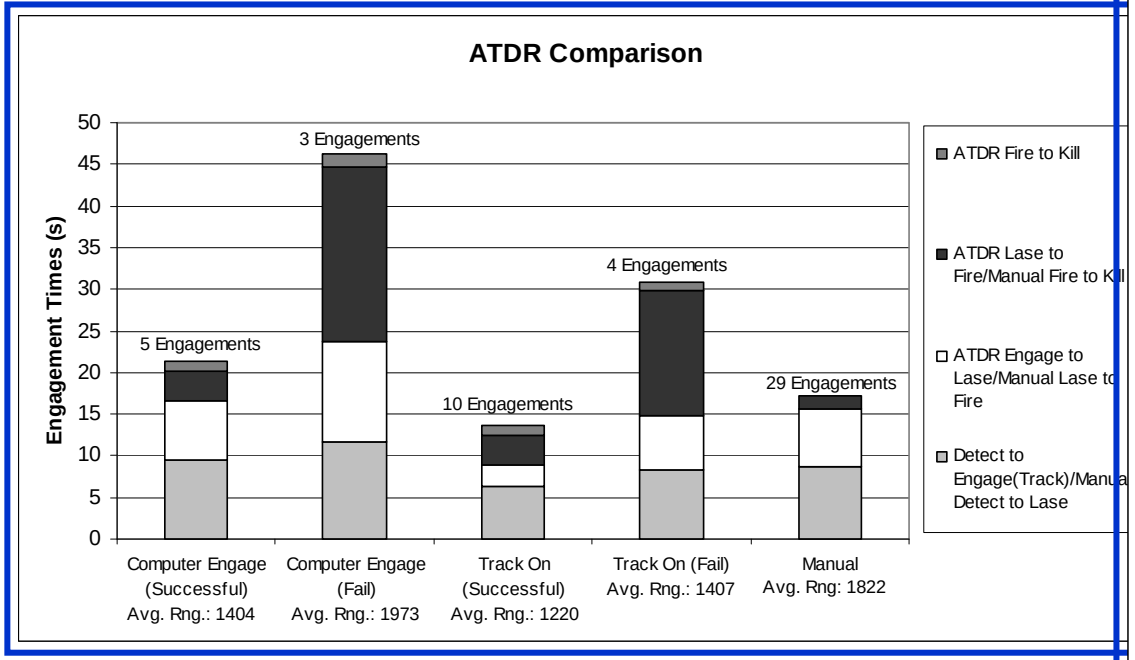
HMD

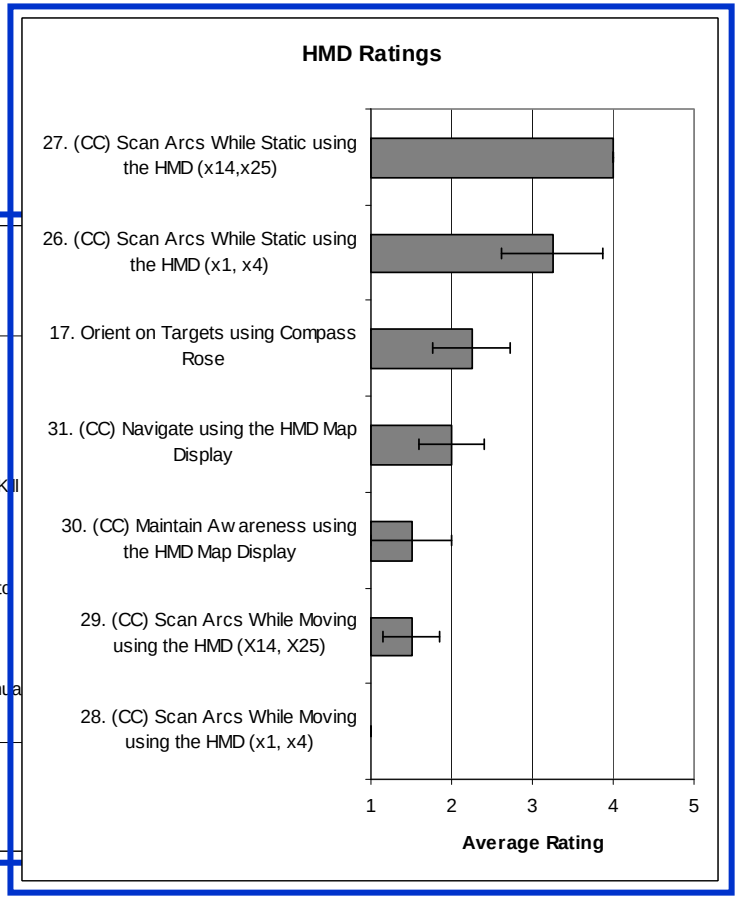
Wide-angle colour stereo immersive view
- **Visual and IR imagery**
- **Symbology to represent tactical and navigational features**
- **Head-tracker**
- **Live mic for DVI and intercom**

Augmented Reality Concept

FAVS Results

- HMDs not suitable for AFVs, but immersive visualization critical for SA
- Three-prong simulation approach successful and validated
- Technology development mostly successful
- Created new TTPs
- Distributed simulation successful





Multi-Mission Concept

- Multi-mission fire control:
  - Direct Fire
  - Non Line of Sight (NLOS)
  - Air Defence
- Use of unmanned vehicles (including organic to the MMEV) for Situation Awareness and target engagement
- Net-centric environment allows external target assignment and remote sensing and target engagement

Combined Arms Operational Construct

TACTICAL LEVEL

Brigade Group

Task Force

Combined Arms Team

Pl / Sect

Bde Gp UAV

Bde Gp HQ

Bde Gp Tac Hel

Bde Gp Arty

Bde Gp Recce

TF HQ

CAT HQ

MMEV TCP

MMEV

TUA

MGS

INF

INF

Combined Arms Simulation Construct

TACTICAL LEVEL

Brigade Group

Task Force

Combined Arms Team

PI / Sect

FFSE UAV RTB

DRDC-Ottawa

Bde Gp UAV

Command Element

Operational Functions

C ommand

S ense

A ct

S hield

S ustain

Bde Gp HQ

TF HQ

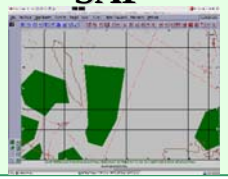
CAT HQ

MMEV TCP

CASE NTS

Bde Gp Tac Hel

SAF



Bde Gp Arty

TARDEC UCD

Bde Gp Recce

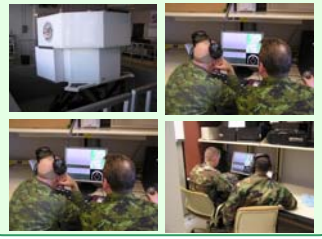
MMEV

TUA

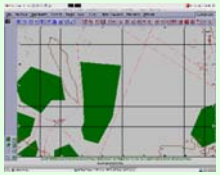
MGS

INF

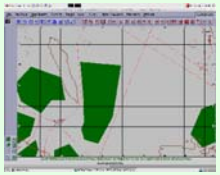
AVTB + 3 x OVS



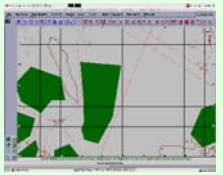
SAF



SAF



SAF

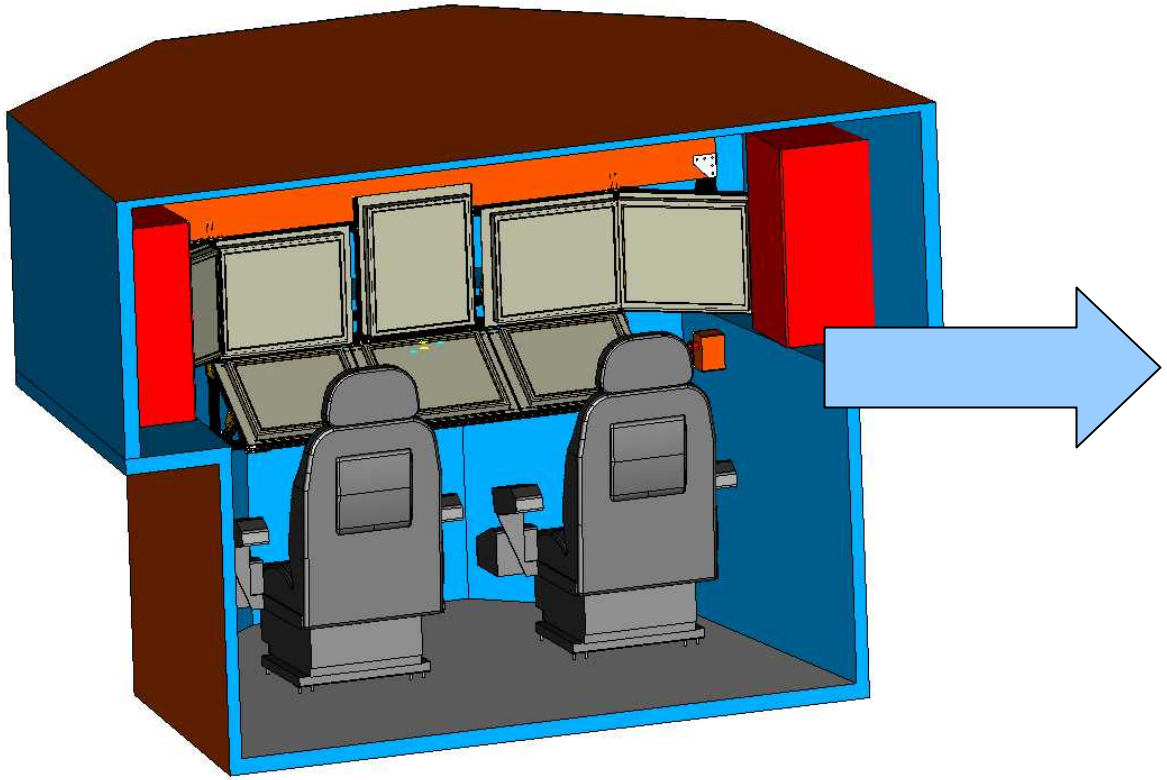


INF

DSS

DRDC-Toronto

- Note use of simulation to design the simulation!



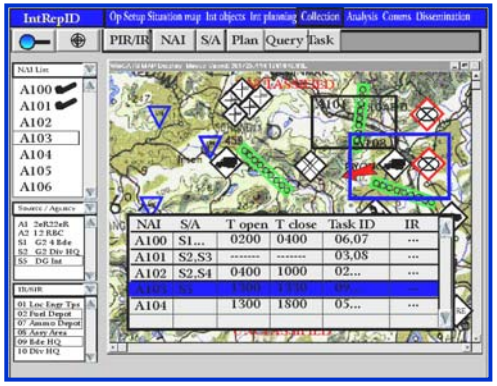
Get picture

MMEV Results

- Improved Situation Awareness
- Benefits of OMI flexibility – roles not specific to crew position
  - Improves ability to conduct multi-role operations
- Increased crew accountability/responsibility
  - Required changes in training and career progression
- Digital vs voice commands
  - Increased speed, decreased SA
- Need direct sensor-shooter communication
- Digital waypoints and shared digital map have high utility

“Perceptual Requirements for Displays”

- Complete HMD evaluation
  - Performance impact
  - Crew integration
- Requirements for relaxed view displays
  - Screen size/orientation/number
  - Display technical requirements
  - Allocation of information
  - Display symbology – style guide
- Wide-area Situation Awareness schemes



“HCI Interaction Issues”

- Direct Voice Input
- Multi-button joysticks/control handles
- Reconfigurable buttons
- Touch screen
- States & modes

“Training Approaches”

- Cannot have too much training!
- Training flow from Powerpoint to hands-on
- Challenges with conversion of attitudes from legacy methodologies and equipment
- How to operate in Net Centric world
- Necessary changes to career progression and training

“Measurement of Human Performance”

- Target engagement
- Navigation
- Command & Control
- Situation Awareness
- Fatigue, workload, sickness
- ***The limitations of HP evaluation! Must consider objective task performance...

“AMVE”

- “Don’t go there” markings
- Way points/fire points
- Boundaries/report lines, etc
- Done in real and virtual vehicles (FAVS)

“Future Military Applications”

- All projects concerned future technologies
- Worked with Army strategic concepts organization
- Includes new TTPs, organizational structure

Conclusions

- In excess of 5000 hours of experimentation has been conducted, and more is on-going in live, virtual, and constructive environments
- Human and system performance measurements have lead to vastly increased understanding of display requirements, training approaches, human-computer interactions, and use of augmented and mixed environments.

The End!

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